POZZOLAN

DEPOSIT

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Subject: POZZOLAN DEPOSIT

Gentlemen:

We would like to take this opportunity to call to your attention a natural " Pozzolan " deposit.

We (Charles R. Lane and W. E. Pearce) hold the mineral and surface leases on the four sections of land containing this deposit.

We have made a thorough investigation from a geological, chemical, physical, and pilot plant production standpoint. The following pages of this brochure give you the more important test data acquired in this investigation.

We are presenting you with this brochure in the hope that you may be interested in a pozzolan material. We would like very much to talk to you if you are interested in actively producing or purchasing pozzolan.

You are undoubtedly aware that the dam construction done in this area will use hundreds of thousands of tons of pozzolan in their construction. This combined with what appears as a ready and waiting concrete industry should make a large and profitable market.

Please call or write me for further details.

Sincerly yours,

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PROPERTY AND EXTENT
OF
MINERAL AND SURFACE LEASES

MINERAL RIGHTS FOR REMOVAL OF VOLCANIC ASH (POZZOLAN)

The South half of section thirty (30) and section thirty one (31) in township two (2) North, Range twenty one (21) East of the Willamette Meridian. Section twenty five (25) and the North half of section thirty six (36) in township two (2) North, Range twenty (20)East of the Willamette Meridian.

SURFACE RIGHT AND THE USE THEREOF

The South half of section thirty (30) and North half of the North half of section thirty one (31) in township two (2) North, Range twenty one (21) East of the Willamette Meridian. Section twenty five (25) and North half of section thirty six (36) in township two (2) North, Range twenty (20) East of the Willamette Meridian.

Five year mineral lease on section thirty six (36) and thirty one (31)

Ten year mineral and surface right lease on the remainder of the property as described above.

GEOLOGY OF ARLINGTON ASH DEPOSITS

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Late Pliocene tuff deposits of Aeolian origin intercalated alluvial pebble and cobbles ocupy a structural downwarp developed in Miocene Columbia River Basalt in an area covering about three townships south of Arlington, Oregon. The deposits were originally mapped by Hodge (Geology of North Central Oregon) as a part of the Shutler Formation which covers a large portion of north-central Oregon. The deposits represent accumulations of airborne materials that were blown from explosive volcanoes located probably to the southwest. Local periods of fluvial activity during periods of volcanic quiescence contributed stream worn conglomerates to restricted areas. The deposits are highly lenticular.

The Arlington ash deposits center near the common corner of T's 1 and 2 N, R's 20-21 E. The deposits have their maximum development in Sec. 36, T 2 N - R 20 E, and easterly in Sections 31, 32, 33, and 34, T 2 N, R 21 E. The deposits thin rapidly both north and south from this tier of section. Their maximum thickness is probably not in excess of 500 feet. The following measured sections indicate the lithologic units of the Shutler Formation in this area. The section was measured in the NE/4 of Section 31 T 2 N, R 21 E, and is described from the top down:

± 100' Tuff, buff to brown, massive, firm to hard, fine to medium grained with common angular lithic grits.

± 30' Conglomerate, cobble, medium to dark brown, moderately to well indurated, hard and resistant. Conglomerate is composed of relatively unweathered basaltic pebbles and cobbles cemented by iron oxide in a medium grained sand matrix.

± 5' Tuff, fine grained, buff to brown, massive, with one thin 1' lens of light grey, soft and friable vitric ash (Pozzolanic material). The tuff is firm to hard.

± 25' Vitric Ash (Pozzolanic material), light grey, massive, soft to locally firm, easily friable. The ash is composed of Rhyolitic glass shards and is nearly 100% free of impurities including other varieties of tuff.

± 150' Tuff, buff, fine to medium grained, firm to hard, tuff occasionally contains angular lithic grit fragments. This is the basal most unit of the section exposed and is estimated to be located approximately 200' above the base of the Shutler Formation.

The critical unit in the above stratigraphic sections is the vitric ash which has been tested for Pozzolanic properties. The bed outcrops in an east-west direction along the north face of Alkali canyon for a distance of approximately one mile. It terminates by lensing out into massive tuffs on both the east and west ends. The bed has an average thickness of approximately 25 feet and a maximum thickness of approximately 50 feet where it is exposed in a steep canyon near the northeast corner of Section 36, T 2 N, R 20 E. The strike of the ash bed is approximately N 75 W and dips from 3-5° to the northeast.

Geology of Arlington ash deposits:

The vitric ash bed is enclosed between a lower firm to hard massive tuff bed and is almost always overlain by a brown, moderate to well indurated conglomerate. The bed is remarkably homogenous throughout its entire outcrop area and rarely does its composition change from a soft and friable vitric ash.

The northward extension below younger deposits described in the stratigraphic section is unknown. It may lens out rapidly to the north or it may extend for a considerable distance. It seems probable that the bed would underly most of Section 25, T 2 N, R 20 E, and Sections 30 and 29 in T 2 N, R 21 E. Its minimum areal extent is therefore estimated at 3 1/2 square miles, including the northern portion of southerly adjacent sections where it outcrops.

Respectfully submitted,

R. J. Deacon
Consulting Geologist

ARLINGTON POZZOLAN DEPOSIT

General summary of enclosed data

Location: Approximately 12 miles west of Arlington, Oregon
Approximately 19 miles from the John Day Dam Site

Quantity: Estimated 1,000,000 cubic yards

Facilities: Railroad within 1,000 yards
Highway within 500 yards
Existing rail siding either direction 5 miles

Physical Properties as found in nature:

Specific gravity..... 2.32 - 2.34
Specific surface as received... 5120 sq.cm./gr Blaine
Gradation:

Screen	% Retained
65	2.8
100	6.2
150	9.1
200	10.7
270	7.5
325	10.1
-325	53.6

Petrographic: Fine volcanic glass particles consisting of mostly glass cords of rhyolitic composition.

Seven Day LIME MORTAR - Compressive averages

ASTM minimum..... 600 p.s.i.
Corp of Engineer..... 900 p.s.i.
Pozzolan as received..... 650 p.s.i.
10,000 Blaine grind (Approx) 1080 - 1675 p.s.i.

Twenty Eight Day Replacement Strengths:

	Percent Replacement		
	20%	35%	40%
	Percent Strength of Control		
Pozzolan as received.....	61.5		29.4
10,000 Blaine grind (Approx)..	100	93-131	86.6

Drying Shrinkage of Mortar Bars:

ASTM maximum..... 0.03% (28 days)
Pozzolan as rec. 20% replacement.... 0.023%
40% replacement.... 0.015%
10,000 Blaine grind (Approximate)
20% replacement....0.016%
35% replacement....0.01 - 0.02 %

REPORT NO. 1

ARLINGTON POZZOLAN DEPOSIT TEST RESULTS

Samples from Arlington deposits, located in Oregon, were tested according to Army pozzolanic specifications for possible use in the John Day Dam (Oregon).

Sample description

No. 2	Original sample from Arlington deposit. It was taken from horizontal hole and was delivered to concrete lab on 10-2-59.
No. 3 to 8	Verticle hole with total depth of 24 feet. Each sample represents 4 feet of depth. Delivered to lab 11-3-59.
No. 9	Composite of samples No. 3 to No. 8.
No. 10	Listed as Hole No. 1 with total depth of 4 feet. Delivered to lab 11-17-59.
No. 11 to 13	Listed as Hole No. 2 with total depth of 12 feet. Each sample represents 4 feet of depth. Delivered 11-17-59.
No. 14 to 15	Listed as Hole No. 3 with total depth of 6 feet. Delivered 11-17-59.

CHEMICAL ANALYSIS — SAMPLES

Oxide Analysis	No. 2	No. 9	Specifications
SiO_2	73.12	72.48	Total SiO_2 + Fe_2O_3
Fe_2O_3	3.14	3.25	& Al_2O_3 not less
Al_2O_3	12.98	12.43	than 70.0%.
CaO	1.60	2.40	-
MgO	0.23	0.61	5.0% Max.
SO_3	None	None	3.0% Max.
L.O.I.	4.90	5.37	10.0% Max.
Total Alkalies	5.24	-	-
Available Alkalies	-	1.12	1.5% Max.

BULK DENSITY

Loose Weight	43.0 lbs/cu. ft.
Compacted Weight	53.5 lbs/cu. ft.
Weight in place (undisturbed)	66.2 lbs/cu. ft.

Sample No. 2 was used in the above determination. The loose weight was determined by placing a weighted sample in a graduate and noting the volume. This sample was compacted by taping in the palms of the hand one hundred (100) times and noting the compacted volume.

PHYSICAL TESTS

SAMPLE	Moisture % (as rec'd)	Specific Gravity	Fineness % Passing 325		(1) Lime - Pozzolan Mortar psi	(2) Cement Pozzolan Mortar % of Control	Water Requirement % of Control	(3) Mortar Dry Shrinkage % of Control	(4) Mortar Alkali Reactivity % of Control
			As Rec'd	Lab Milled					
Army Specifications	-	Max. 3.00	-	Min. 88	Min. 900	Min. 75	Max. 115	Max. 0.03	Min. 75
ARLINGTON									
2 a. Not Calcined	-	2.34	72.6	91.9	1390	106	99	0.01	81.5
2 b. Calcined	-	-	-	-	1380	106	99	-	-
3 Not Calcined	10.4	2.32	25.0	93.2	1367	96.6	101	0.01	95.0
4 " "	10.2	2.32	32.9	95.7	1300	93.6	101	0.01	94.0
5 " "	11.7	2.33	65.8	96.6	1383	115.4	101	0.01	114.0
6 " "	16.3	2.33	49.3	93.2	1508	95.3	101	0.01	101.0
7 " "	17.8	2.33	53.9	97.5	1433	111.7	101	0.01	-
8 " "	14.3	2.33	50.3	93.2	1367	99.5	101	0.01	104.0
9 (comp 3 - 8)	-	2.33	-	97.5	1508	111.8	101	0.01	100.0
10 Not Calcined	24.1	-	72.0	98.0	1675	-	-	-	-
11 " "	14.7	-	52.0						
12 " "	8.5	-	76.0	97.6	1290	-	-	-	-
13 " "	9.0	-	76.0						
14 " "	9.1	-	80.0						
15 " "	9.9	-	90.0	93.0	1065				

Note: 1. Compressive strength of lime-pozzolan mortar a 7 days.
2. Pozzolanic strength of cement pozzolan mortar at 28 days.
3. Increase in drying shrinkage of mortar bars at 28 days.
4. Reactivity with cement alkalies, reduction of mortar expansion at 14 days (cement - Ideal R.C.)

REPORT NO. 2

ARLINGTON POZZOLAN EVALUATION

A preliminary material and process study was made on the volcanic ash sample submitted. It was the purpose of the investigation to establish the relative pozzolanic activity of the material as received without treatment, as well as to determine whether an improved quality product could be achieved through suitable upgrading and processing techniques.

PHYSICAL CHARACTERISTICS This material forms a loosely consolidated aggregate of fine volcanic glass particles, some portions of the sample being free-flowing, others lightly compacted and lumpy. It was necessary to lightly crush the sample for screening and seperating purposes. Moisture as received was 3.18%, and it would seem probable that this moisture may average around 5% or more in freshly-exposed deeper cuts at shovel-digging depths, especially during winter operations.

The particle-size gradation seems to be over a relatively wide band below 50-mesh, with slightly more than half being below 325-mesh size. Specific gravity was found to be 2.32, and specific surface 5120 sq. cm./gr Blaine. Particles examined under the microscope are sharp-edged and of platy shape, being mostly glass chards, and probably of rhyolitic composition. Grinding to finer sizing was found to be surprisingly easy, and is evidently due to the ready breakage of the flat particle shapes. This particle shape characteristic no doubt also accounts for the relatively high specific surface without extreme fineness, and explains the peculiar low water requirements (and probable low shrinkage) when mixed with mortars to standard consistency and flow. These are all rather important properties enhancing the potential qualities of a pozzolan.

Several screen analyses were made, each somewhat different in result depending onthe type of pre-crushing, and the amount of lumpy material in the sample. Typical distribution was as follows:

+ 65 mesh.....	2.8 %
+100 mesh.....	6.2 %
+150 mesh.....	9.1 %
+200 mesh.....	10.7 %
+270 mesh.....	7.5 %
+325 mesh.....	10.1 %
-325 mesh.....	53.6 %
5120 sq.cm./gr Blaine	

In order to save initial time in this study, it was assumed that some upgrading of the material would be possible, and thus several samples were processed under simulated commercial conditions of air seperation as well as grinding and heat activation. No accelerators were investigated for the material in this study.

HEAT ACTIVATION (20 minutes, oxidizing atm.)

The material was brought to various activating temperatures under heating up and holding times, as well as commercially reproducable atmospheric conditions. Comparisons were made by measuring the depth of penetration of a Vicat needle in a thickening paste of the material with lime and water. Results were as follows:

SAMPLE	ELAPSED TIME (Hours)							
	0	8	42	85	109	140	174	
Untreated.....	41	41	41	39	22		4	mm
Calcined to 1100° F.....	42	42	45	45	45	30	2	mm
Calcined to 1300° F.....	43	43	39	39	30	17	5	mm
Calcined to 1500° F.....	40	40	40	37	29	11	3	mm
Calcined to 1700°F	41	41	41	34	32	22	3	mm
Snake River sample	55	55	55	55	55	39	19	mm

Results were not conclusive enough to establish a marked improvement in setting-up time via calcination. The material reacted generally after about 100 hours, an elapsed time which is somewhat delayed compared to many pozzolans. There was a slightly stronger set with material calcined from 1500° to 1700° F, but was not deemed to sufficient to justify heat treatment as a commercial processing expedient. No fusion took place at 1700° F. All further up grading was therefore done by means of air classifying and/or grinding.

The following product samples were made up and tested relative to strength with lime-sand mortar and replacement by weight for cement in cement-sand mortar cubes:

1. A known pozzolan for control
2. Arlington ash as received
3. Air-separated fines fraction
4. Air-separated course fraction
5. Ash ground to 10,000 Blaine

7 - DAY LIME MORTAR COMPRESSION (Averages)

ASTM minimum	600 p.s.i.
Control Pozzolan	820
Ash as received (71%-200 mesh)	650
Air classified fines (93% - 200 mesh)	710
Air classified course (27% - 200 mesh)	270
10,000 Blaine grind	1080

AUTOCLAVING RESULTS

Eight different mortar mixes were made up with variously processed ash in order to test the relative accelerated compressive strength under commercial steam autoclaving cycle.

SAMPLE	CEMENT REPLACEMENTS BY WEIGHT		
	20 %	40 %	0 %
100 % portland cement control..			5,950 p.s.i.
Ash as received	3,440	2,680	
Air-classified fines	3,435	3,050	
Air-classified course	3,010	2,220	
10,000 Blaine grind	4,205	4,190	

Curing under steam pressure has different effects on concrete made with pozzolan-replaced cement, and this particular pozzolan is one of those which are not aided in strength development speed through autoclaving. Whether this also holds true for lime-pozzolan mixes would yet have to be established.

CHANGE OF DRYING SHRINKAGE OF MORTAR BARS (ARLINGTON POZZOLAN)

ASTM Maximum	0.03% (28 days)	
Ash as received (20% cement replacement)	0.023%	less
(40% cement replacement)	0.015%	less
10,000 Blaine grind (20% replacement)	0.016%	less
Air classified fines (20% replacement)	0.030%	
(40% replacement)	0.058%*	
Air classified coarse (20% replacement)	0.002%	less

While these shrinkages fall well within ASTM requirements, they are not consistant. However, both the ash as received as well as the 10,000 Blaine grind are low enough to allow higher replacement values or finer grinding if required. Thus it is possible to up-grade the ash by classifying and grinding without excessive water requirements and subsequent shrinkages.

* This result must be in error since later work has not shown any results this high.

28 DAY REPLACEMENT STRENGTHS

SAMPLE	WEIGHT REPLACEMENTS 0 %	20%	40%
Portland cement control..	3,370		
Ash as received.....		2,072	990 P.S.I.
Air-classified fines.....		1,925	1,432
Air-classified course....		1,250	803
10,000 Blaine grind.....		3,375	2,920

MORTAR MIX FLUIDITY AND WATER REQUIREMENTS

SAMPLE	PERCENT FLOW	WATER ADDED
20% Cement Replacement		
Ash as received.....	100	300
Air-classified fines.....	120	338
Air-classified course.....	100	365
10,000 Blaine grind.....	116	280
40 % CEMENT REPLACEMENT		
Ash as received.....	115	337
Air-classified fines.....	105	320
Air-classified course.....	110	380
10,000 Blaine grind.....	106	265

GENERAL OBSERVATIONS

These preliminary results have shown that the material as received has considerable pozzolanic value, and meets the ASTM minimum lower value for 7-day strength of pozzolanic reactivity specification. The material is not sufficiently improved by heat activation to warrant further evaluation on that score, although the Snake River sample might be so tested.

It has been shown that the material can be upgraded somewhat by air classification only, and that a rather high quality pozzolan can be produced by grinding, the optimum of which has not yet been determined. This grinding does not increase the normally expected higher water requirements and possible shrinkages.

The material as potentially mined would not, in itself, represent a high quality competitive pozzolan except, perhaps, as a low-cost cement replacing admix for dam concrete purposes up to perhaps 25 % by specific volume. As a processed pozzolan, however, the Arlington ash would represent a competitive medium to high quality pozzolan for general concrete and masonry products purposes, with specific properties in relation to chemical alkali, acid, and sulfate resistance and buffering action yet to be established. In the tests made to date, the ground material would rate with the better Eastern fly-ash pozzolans on strength, as well as water requirements.

It might be pointed out that the particular process requirements for producing an all-purpose high quality pozzolan from the Arlington ash were found to be relatively easy and economical to achieve as compared to certain sedimentary or other types of volcanic raw materials. It would require a combination drying-air-seperating process in which the coarse fraction of about 25 % is ground and recombined with the fines to form a product of 10,000 Blaine or more specific surface. In view of the relatively low moisture content, plate structure and brittleness of the glass particles, and need for grinding only a small fraction of the total material for achieving quality and uniformity, process economics will be more favorable than in many pozzolans.

As a next-step consideration in developing this project, preliminary manufacturing costs and plant investment costs could be estimated to evaluate the economics of an operation processing Arlington raw material. Such an evaluation study would furnish a basis for further decisions. It would require inspection of deposit and site to obtain preliminary cost data, as well as an arbitrary tonnage estimate and division of potential operation for production of short-term dam pozzolan aggregate and general market pozzolan products.

REPORT NO. 3
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January 31, 1961

We have completed our tests on the sample of natural pozzolan from the vicinity of Arlington, Oregon, which you sent to our Research Laboratory a couple of months ago. The material was ground in our laboratory mill to finenesses of 6,850 , 9,980 Blaine. The material ground to the higher fineness had properties quite similar to those we obtained with our calcined shale pozzolan. The results of our tests are tabulated below, these having been run in accordance with the current Corps of Engineers' Specifications.

Specific Gravity	2.34	
Blaine S.A., $cm.^2/g.$	6850	9980
Lime Activity, psi	980	1280
Contribution to Comp. Strength, percent	118	131
Water Req., percent	97	97
Reduction of Alkali Reactivity, percent	59 67	65 78
Increase in Drying Shrinkage, percent	0.01	0.02

REPORT NO. 4

LABORATORY TEST RESULTS ON PILOT PLANT PRODUCTION

Tested in accordance with ASTM C 402-58T

Seven day LIME MORTAR compressive averages

ASTM minimum	600 psi
Pilot Plant grind	950 psi
- 325 Fraction of above grind	990 psi
Dust collecter fines	1150 psi

Twenty eight day strengths

Portland cement control	5020 psi	
35% replacement..(Pilot plant grind)	4290 psi	85%
35% replacement..(-325 fraction)	4665 psi	93%
35% replacement..(Dust coll. fines)	4600 psi	92%

Water requirements

Pilot plant grind	103%
- 325 Fraction	98%
Dust Collecter fines	104%

Blaine sq. cm./ g.

Pilot plant grind	7250

- 325 fraction

Pilot plant grind	94%

REPORT NO. 5

EVALUATION OF THE PILOT PLANT PRODUCED POZZOLAN IN BLOCK CONSTRUCTION

	Control 1	20% Pozz	Control 2	30% Pozz	Control 3	50% Pozz	Control 4
Cement	275	220	275	192.5	275	137.5	275
Pozzolan		55		82.5		137.5	
Sand	400						
Gravel	500						
Pumice	600						
Yield No. Block	52	56	56	56	56+	58+	57

The above blocks were made on May 13, 1961 between 9 AM and 11:30 AM. They were immediately placed in a steam curing room and subjected to the standard curing cycle; 2 hour preset, 3 hour at 185° F., soaked overnight. The blocks were removed from the curing room on May 15, 1961 and taken to the laboratory for testing. The blocks were immediately capped and then dried before breaking. The following results were obtained.

COMPRESSIVE RESULTS IN P.S.I.

1150	1242	1091	1108	986	839	1049
1158	1175	999	1091	1057	818	1003
1175	1209	1209	1167	1125	780	1070
% of control *	114%		105%		76%	

* The first set of control blocks were omited from the average in determining the % calculation because of their yield.

The remaining blocks are being cured under yard conditions with one set of five blocks each being placed in a standard curing room maintained at 73 + 3° F. and 100% humidity. These blocks will be tested for all the standard criteria at the appropiate ages. A supplementary report will be issued.

The blocks remaining in the yard were placed in the drier on May 24,1961 and dried at approximately 300-350° F. for 20 hours. A set of blocks was broken at 14 days and the following results obtained.

Compressive results in P.S.I.

Controls	20% Pozz	30% Pozz	50% Pozz
# 1 1175	1260	1210	1030
# 3 1240	1220	1230	1015
# 5 1175			
# 7 1290			

EVALUATION OF THE PILOT PLANT PRODUCED POZZOLAN IN *BLOCK CONSTRUCTION

The blocks which had been submitted to the complete manufacturing cycle and were 14 days old at time of sampling were subjected to a series of tests and the results recorded below:

Marked	Weight of unit Dry	Total Absorp. %	Absorp. #/cu.ft.	Linear Shrinkage ASTM C 426-58T	Compression Gross Area P.S.I.
CONTROL					
Set 1.	27.08	16.16	14.98	0.046	1385
	26.05	16.50	15.07	0.051	1210
Set 3.	26.10	16.27	14.93	0.051	1240
	26.33	16.42	15.02	0.051	1285
Set 5.	26.48	16.40	15.00	0.051	1410
	26.00	16.33	14.80	0.055	1320
Set 7.	26.22	16.53	14.96	0.055	1305
	26.11	16.72	15.08	0.046	1310
POZZOLAN BLOCK					
Set 2.	26.10	17.32	15.71	0.042	1350
	25.90	17.20	15.59	0.041	1290
20% Pozz.	26.14	17.04	15.42	0.041	1260
	25.91	17.49	15.80	0.044	1300
	26.52	17.34	15.83	0.046	1350
Set 4.	26.12	18.15	16.47	0.038	1340
	26.65	17.25	15.91	0.035	1475
30% Pozz.	26.45	17.72	16.24	0.036	1410
	26.10	18.04	16.35	0.038	1350
	26.65	17.21	15.94	0.037	1420
Set 6.	25.56	20.75	18.49	0.027	1125
	25.52	20.43	18.20	0.025	1115
50% Pozz.	25.25	20.35	18.14	0.025	1115
	25.25	20.61	18.39	0.027	1125
	25.61	20.23	18.09	0.023	1190

* The compression tests were made on the capped and dried blocks.